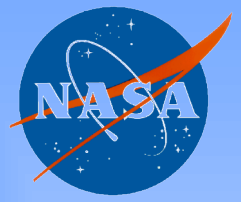

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Improving First-Guess Surface IR Emissivity Models

AIRS Science Team Meeting
May 3-6, 2005

Evan Fishbein
California Institute of Technology
Jet Propulsion Laboratory

5 May 2005

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Why Improve Emissivity First-Guess?

- **Currently large component of final solution is from first guess**
- **Cloud-clearing maps inter-footprint surface variability into cloud field**
  - Include footprint-dependent surface in Obs-Calc for CC
- **Reduce degree-of-freedom by coupling emissivity at different frequencies**
- **Improve convergence rate**

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Current Surface Emissivity First Guess

- **Final retrieval initialized with surface emissivity regression**
- **Surface emissivity training set from AIRS Level 2 Simulation System (AL2SS)**
- **AL2SS surface model was not designed for this purpose**
  - Provides worse-case surface variability
  - Statistics are not representative
  - Uniform skin temperature over footprint

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AL2SS Surface Model

- Contains
  - Two "soil" types: quartz sand and urban sprawl
  - Three vegetation types: conifer, deciduous, grass
  - Constant salinity sea water
  - Two types of ice: ice and snow
- Each footprint is a mixture of components based on
  - Interpolated 1km NDVI at center of footprint
    - (not averaged over AIRS footprint)
  - 1 km simplified IGBP Global Land-Cover Type
  - Vegetation type randomly distributed among possible vegetation types on
- Lambertian emissivity (except sea water)
- Constant skin temperature

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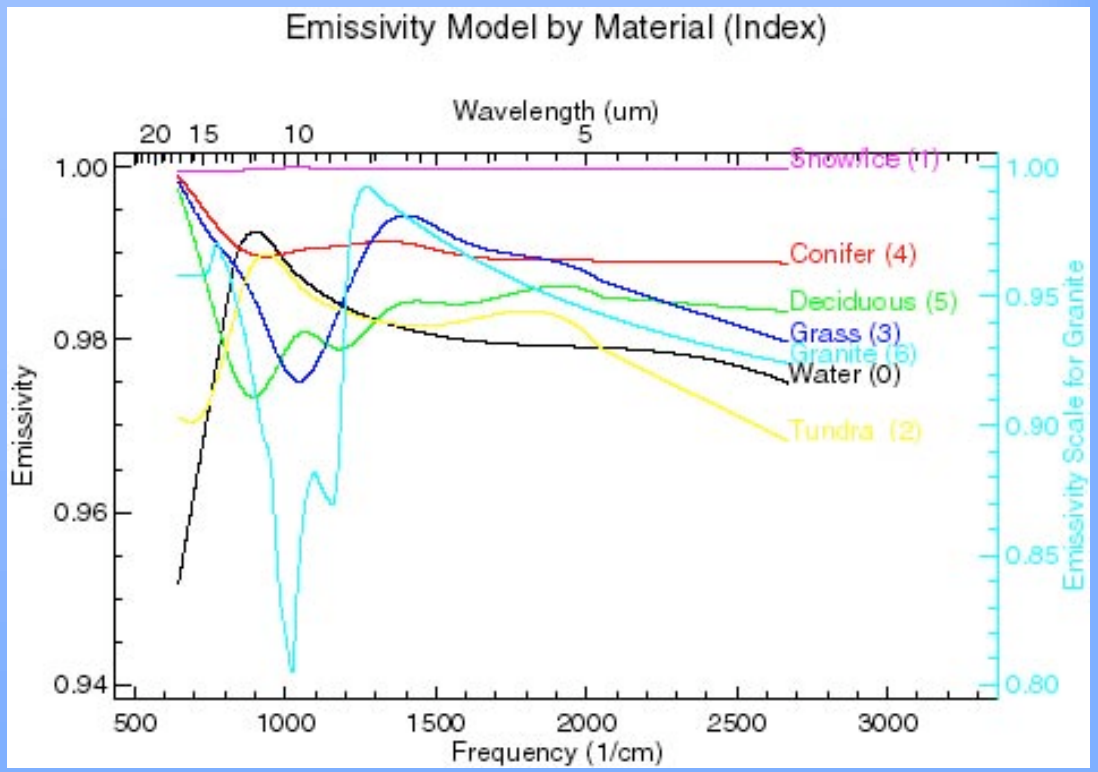
Material Emissivity Models

- Extrapolated shortwave emissivities
- Quartz has anomalous Reistrahlen band
- Ice emissivity depends on grain size and water content



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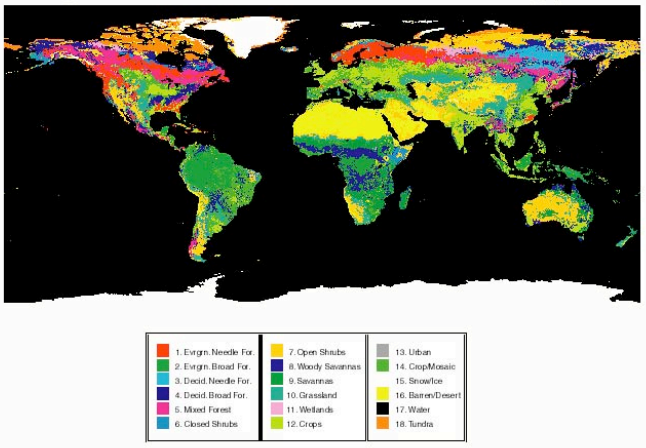
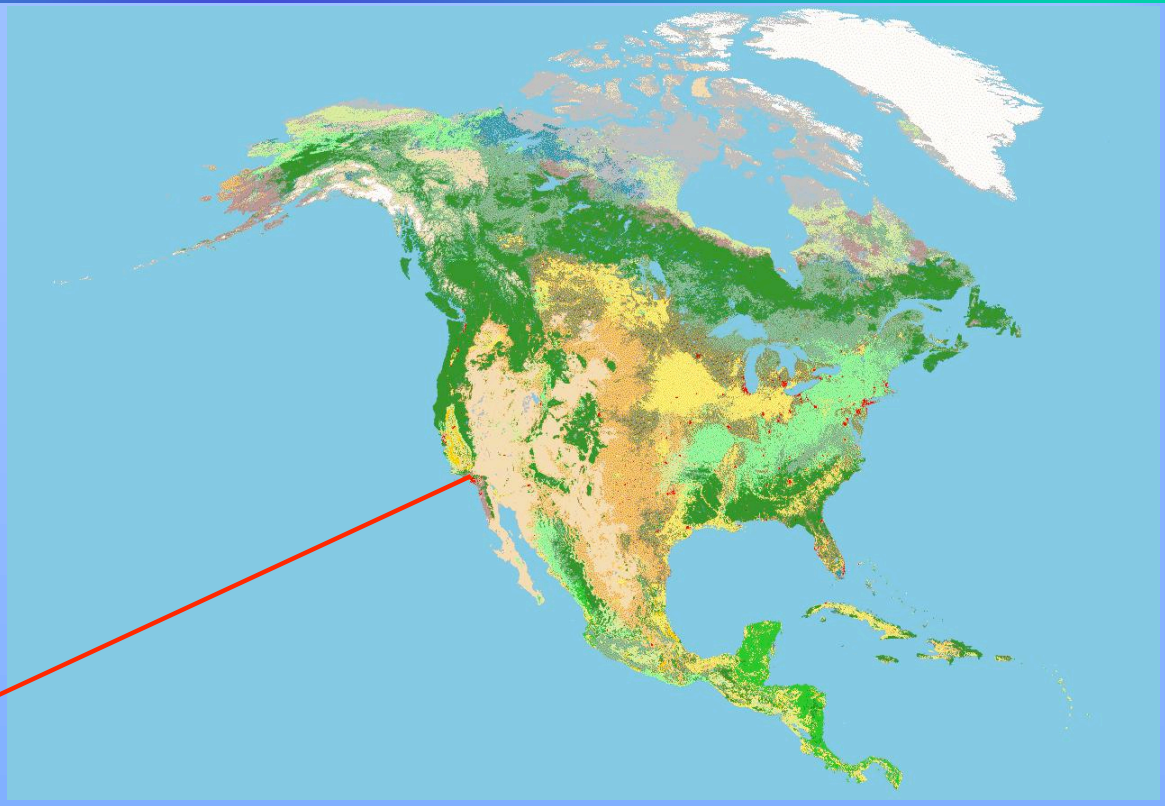
AIRS Atmospheric Infrared Sounder — Jet Propulsion Laboratory, California Institute of Technology

Global Land Cover Characterization

International Geosphere Biosphere Programme Global Land Cover Type





- **Actively developed by MODIS Land Science Team**
- **Types of vegetation relatively unimportant**

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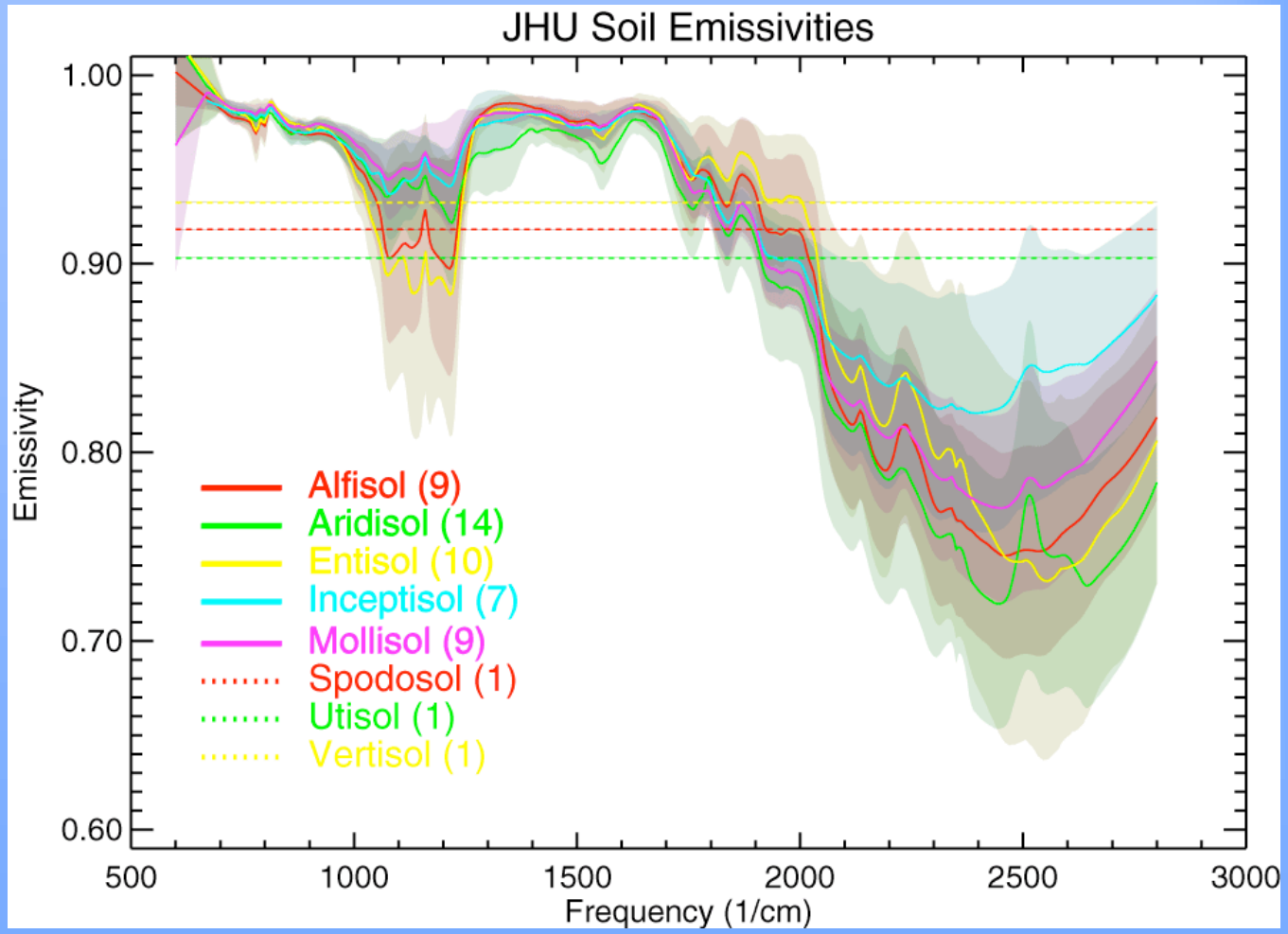
Soil Variability

Soil Classification

- Organic material
- Weathering



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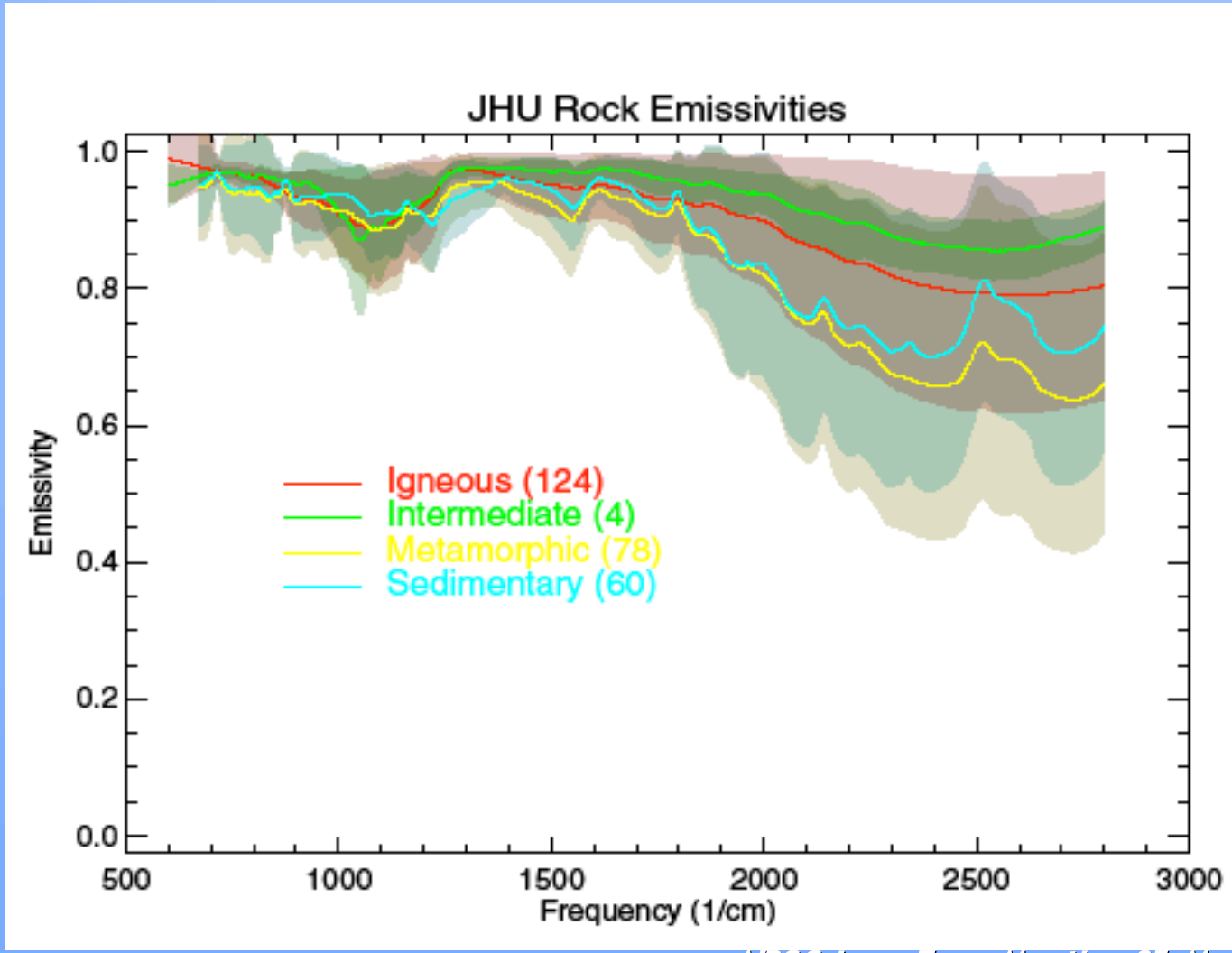
Rock Variability



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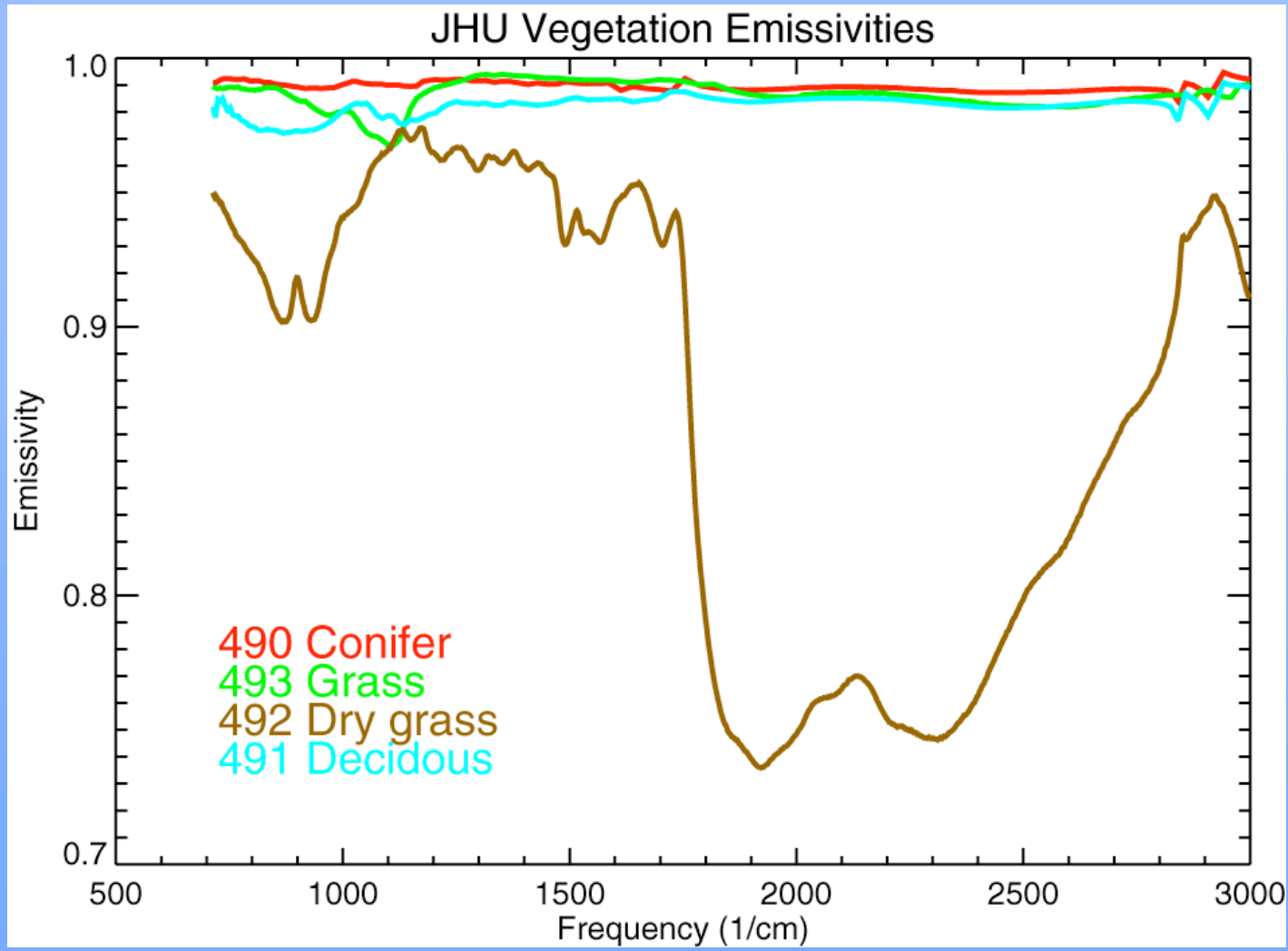
Vegetation



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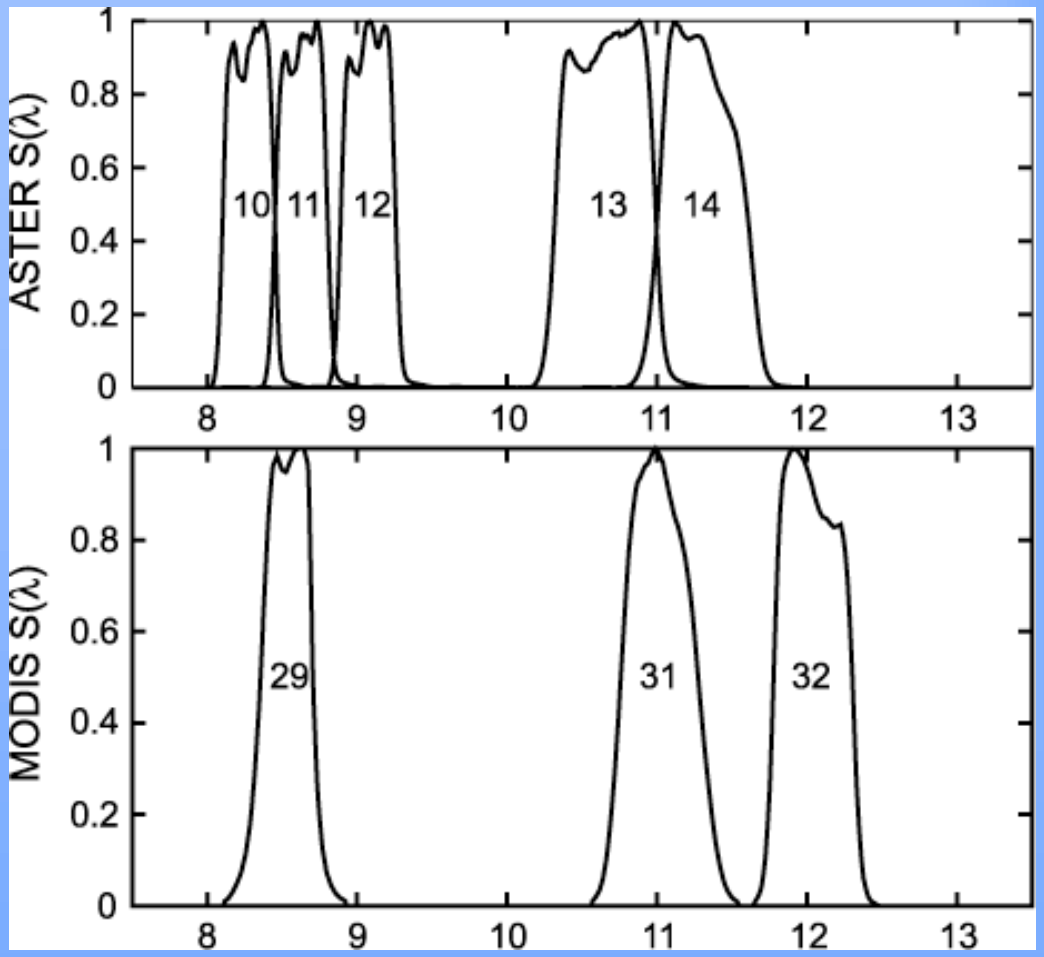
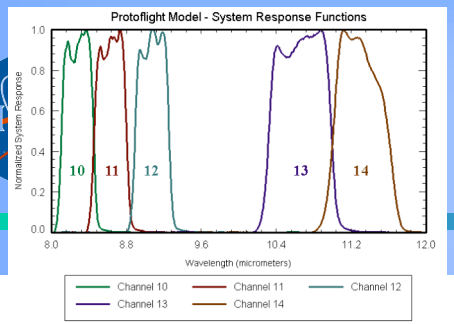
Observed Variability

- **ASTER**
  - Swath width: 60km
  - Spatial Resolution: 90m
- **MODIS**
  - Swath width: 2330 km
  - Spatial Resolution: 1000 m





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ASTER Emissivity

Band 14
(11.3 µm)

Band 13
(10.6 µm)

Band 12
(9.1 µm)

Band 10
(8.3 µm)

-4.4 -4.0 -3.6

32 31 30

0.94 0.95 0.96 0.97 0.98

0.77 0.82 0.86 0.91 0.96

0.75 0.80 0.85 0.90 0.95

Differ in all Bands

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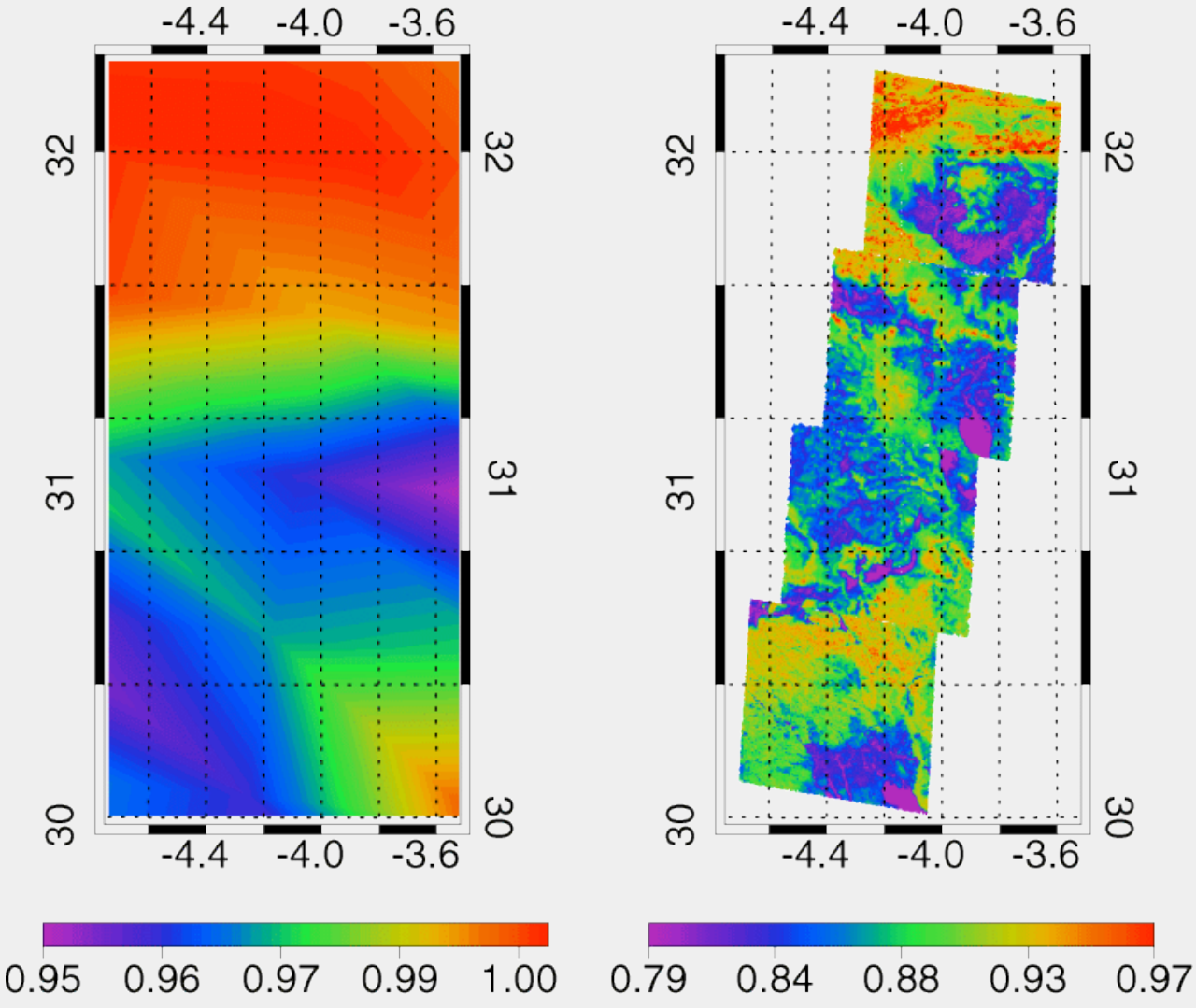
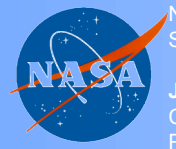
AIRS ASTER Intercomparison

8.65 μm





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Factors Affecting First Guess Emissivity

- Amount of vegetation and view of soil
- Soil composition and particle size
- Surface type - snow / ice, vegetation type
- Soil moisture

First Guess Options

1. **Construct spectral emissivity map**
   - Monthly L3 product (possibly higher spatial resolution)
   - Emissivity maps from ASTER/MODIS
   - Issues
     - Ignore non-Lambertian behavior
     - Spectral coverage
     - Vegetation annual and seasonal variability
2. **Evaluate emissivity using extended simulation framework**
     - More components and means of estimating components
     - Spectral model of components
   - Issues
     - Soil composition model
     - Vegetation in polar winter
     - Can components be derived from long wave emissivity
       - Use MODIS/ASTER emissivities to determine composition

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Using Land Cover Type to Organize Activity

Easy

- **Tropical Deciduous forests**
  - High vegetation cover
  - Weak seasonal variability
  - Lambertian
- **Conifer Forest**
  - Moderate vegetation cover
  - Weak seasonal dependence
  - Some non-Lambertian behavior
- **Mid-latitude Deciduous forests**
  - High vegetation cover
  - Strong seasonal dependence
  - Lambertian (?)

Difficult

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Using Land Cover Type to Organize Activity

Hard

- **Grasslands**
  - Low vegetation cover
  - Strong seasonal variability
  - Non-Lambertian
- **Marsh**
  - Variable vegetation
  - Strong seaonal variability (vegetation and soil)
  - Lambertian (?)
- **Desert**
  - No vegetation
  - Very weak seasonal variability
  - Lambertian (?)

Harder

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Using Land Cover Type to Organize Activity

Hard

- **Tundra**
  - Low vegetation cover
  - Diurnal, weekly, seasonal variability
  - Snow, ice and frozen soil
  - Lambertian (?)
- **Snow / Ice**
  - Diurnal, weekly, seasonal variability
  - Non-Lambertian (?)
  - Microwave even more complicated
- **Urban (?)**
- **Varied Topography**
  - Variable surface pressure and water vapor
  - Heterogeneous soil composition

Good Luck

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